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THE INSTRUMENTATION AND SEA TRIALS OF A HYDROFIELD 20 TARGET BO--ETC(U)
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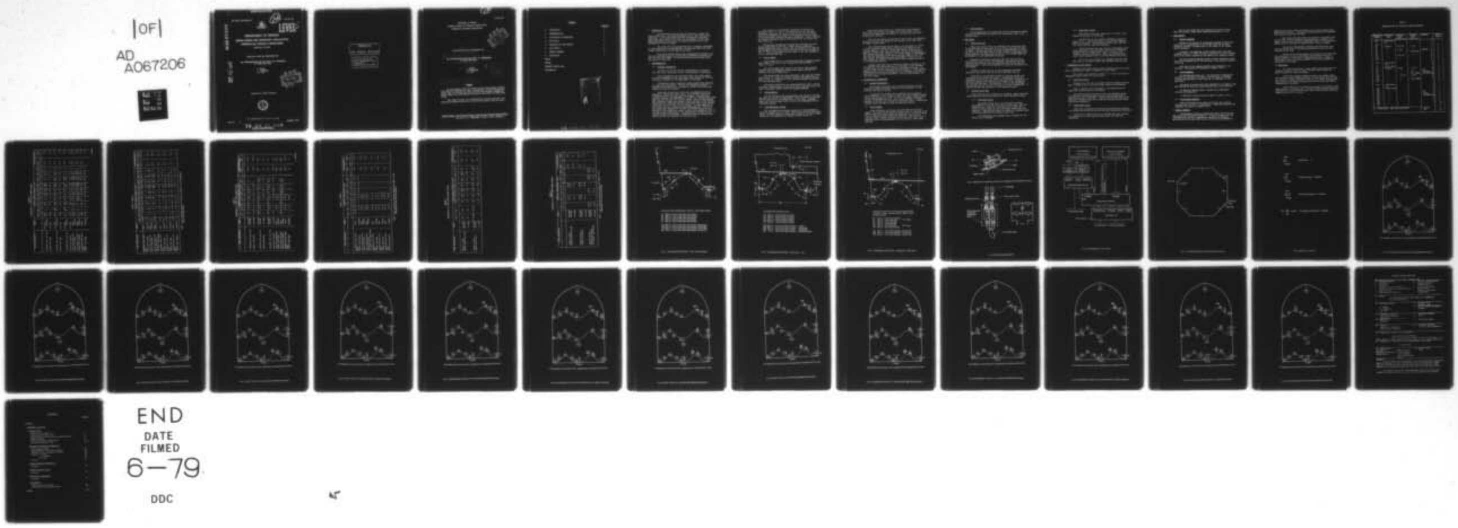

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MELBOURNE, VICTORIA

Structures Technical Memorandum 283

THE INSTRUMENTATION AND SEA TRIALS OF A HYDROFIELD 20 TARGET BOAT HULL

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THE INSTRUMENTATION AND SEA TRIALS OF A HYDROFIELD 20 TARGET BOAT HULL

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SUMMARY

At the request of the Directorate of Naval Ship Design, Aeronautical Research Laboratories (ARL) instrumented a six metre fibre glass target boat and recorded the output signals from pressure transducers, strain gauges and accelerometers during both calm water and rough water trials.

This report details the instrumentation fitted to the hull, the problems encountered during the trials and the results from the tests.

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1. INTRODUCTION

The Hydrofield series of boat hulls feature a unique twin tunnel design with a very high performance under a wide range of sea conditions. As the Royal Australian Navy had acquired a six metre fibre glass target boat of this type, the Directorate of Naval Ship Design requested that ARL assist in obtaining further data on the performance of this hull shape.

The target boat was instrumented with 16 pressure transducers, 11 strain gauges and 2 accelerometers, records being taken from these sensors during both calm and rough water trials.

This report briefly details the instrumentation fitted to the hull, the problems caused by using pressure transducers unsuitable for the salt water environment, the tests conducted and the results from the trials at Jervis Bay.

2. INSTRUMENTATION

2.1 Pressure Transducers

The Port side of the hull was instrumented at 16 stations with well known, integrated circuit, gauge pressure, transducers.

These transducers were relatively cheap, had a high output and were recommended for use with strong salt solutions in the only literature available at the commencement of the tests.

Unfortunately these transducers failed rapidly when subjected to a sea water environment. Failure was indicated by rapidly increasing electrical noise, followed by a drift of the zero until complete failure had occurred.

Tests were carried out at ARL while instrumentation was in progress at Jervis Bay Missile range, in an attempt to proof the transducers against the salt water environment. The units were sprayed internally with Pentalube 26, filled with outboard motor lower gear case oil and also with silicone grease. None of these methods were successful though they helped to delay the onset of the failure. These tests also indicated that the units would retain their initial sensitivity up to the time of final failure. At the completion of the trials only five transducers remained operational. Sea trials had already been delayed for 2 months, and further delays while a solution to the problem was sought, could not be justified in view of the RAN's urgent requirements. The manufacturer's report on the initial failure was six weeks in preparation and not received until some time after the completion of the sea trials.

The location of the pressure transducers in the hull is detailed in FIGS. 1, 2 and 3. Initially both 60 PSI and ±5PSI transducers were used, but after an initial test run, the 60 PSI units were withdrawn from service as the pressures were too small to give meaningfull results with these transducers. Table 1 details the pressure transducer used at each location for the initial and final test runs.

The pressure transducers were mounted inside the hull using special clamps glued to the hull. Rubber sealing washers and packing pieces were used to ensure that the pressure inlet tubes of the transducers were flush with the outside of the hull as shown in FIG. 4. Four core shielded cable was used to wire the transducers to the instrumentation pack.

2.2 Strain Gauges

Strain gauges with a 2 cm gauge length and a polyester backing were bonded to the hull at the 11 measuring stations shown in FIGS. 1, 2 and 3.

Two active gauges were bonded to the hull at each location together with two temperature compensating gauges attached to a separate fibre glass dummy plate.

Each gauge bridge was wired internally, with 7/010 PVC covered hook up wire, to a set of 4 terminals glued to the dummy plate as shown in FIG. 5. Connection to the instrument package was by means of 4 core shielded cable.

Each gauge installation was waterproofed, first with a coating of solvent thinned acrylic strain gauge coating and then with a two part, polysulphide rubber, electrical potting compound.

2.3 Accelerometers

Two force balance type accelerometers were fitted to the hull, one under the deck at the approximate centre of gravity of the boat and the other inside the extreme front of the cabin. Shielded multi core cable was again used to connect the transducers to the instrument package.

2.4 Instrumentation Package

The instrumentation package contained two old photographic recorders together with the signal conditioning units for the transducers, the power supplies, timing pulse generator and strain gauge calibration and identification systems as shown in FIG. 6.

These units were mounted on a plywood base which rested on 10 cm thick foam plastic, the whole unit being secured inside a tubular steel frame which was screwed to the deck near the centre of gravity of the hull.

Power for the system was provided by four twelve volt batteries, resting on the deck and secured to the outside of the steel frame by rubber octopus straps.

Trace identification was provided in the recorders by a built in trace interupter system which interupted each channel in the correct sequence. The strain gauges were further identified by a sequence initiated each time the recorder run button was actuated. This dropped the bridge voltage on the strain gauges to approximately zero near the beginning of the record and then ramped it up to the full voltage, thus permitting each galvanometer to return to its zero position for positive identification before ramping clearly up to its operating position.

Because there were only 21 measuring channels available on the two recorders and some 29 sensors to be recorded, it was necessary to repeat each test run after changing instrumentation plugs. As shown in table 2 Plug A permitted 10 strain gauges, 8 of the pressure transducers and the two accelerometers to be recorded, while plug B dealt with all 16 pressure transducers, the two accelerometers and one strain gauge.

3. CALIBRATION OF TRANSDUCERS

3.1 Pressure Transducers

The pressure transducers were calibrated directly onto the recorders by applying pressure direct to the transducers in the bottom of the hull as follows:

A regulated air pressure from a reducing valve was fed to each transducer in turn, through a rubber hose with a modified rubber suction cup mounted on the end. The cup was pressed firmly against the hull surrounding the inlet tube of the transducer to supply pressure to the unit and to check the system for leaks. A calibrated pressure gauge was used to monitor the pressure applied.

3.2 Strain Gauges

Shunt calibration facilities were provided for the strain gauges. Both positive and negative strains could be simulated on the gauge bridges by shunting either the dummy gauge or the active gauge with an accurately known calibration resistor. High stability resistors with a nominal resistance of 75k Ohms were used to give a simulated strain of approximately 392 micro-strain at each gauge position.

3.3 Accelerometers

The accelerometers were calibrated into the recorders by simply turning them upside down to produce a 2G acceleration step on the recorder trace.

4. SEA TRIALS

4.1 Initial Test Run

During the initial test run, manoeuvres were carried out both in the calm water of Jervis Bay and in a force 3 sea state outside the heads. Records were taken at speeds of approximately 15, 25 and 33 knots in the calm water and at 15 and 25 knots in the rough water. Higher speeds in the rough water proved to be too uncomfortable for the operators of the instrumentation system.

Manoeuvres consisted of straight runs both into and with a following sea, turns to Port and Starboard, jump starts and crash stops and straight runs with seas quartering on both the Port and Starboard bows. Each run was repeated to enable all the sensors to be recorded.

Leakage of light into one of the photographic recorders resulted in the loss of much of the data from this test run.

Pressures on the foreward sections of the hull proved to be far smaller than had been anticipated. Consequently the 60 PSI transducers fitted to the hull gave little meaningful information, so they were replaced where possible by the spare ±5 PSI transducers for the final test runs. The remainder of the 60 PSI transducers were removed from the hull and the holes in the hull blanked off. No further readings were possible at these measuring points.

4.2 Official Trial Runs

These tests were also conducted in two parts, namely calm water trials inside Jervis Bay and rough water trials outside the heads.

4.2.1 Calm Water Trials

Runs were carried out in two directions at engine revolutions of 2000, 3000, 4000 and full engine RPM. Each run commenced with a jump start and ended with a crash stop. A series of figure eights at the above engine speeds was also completed , entering and leaving the figure at a constant speed and turning under both half helm and full helm.

All manoeuvres were performed twice to permit all the sensors to be recorded.

4.2.2 Rough Water Trials

Rough water trials were carried out in a force 3 sea outside the entrance to Jervis Bay.

The boat was run on a series of octagonal courses as shown in FIG. 7, stops being made at two points on opposite sides of the figure. Engine speeds of 2000, 3000, 4000 and full engine RPM were used where possible.

During the final test runs with all the pressure transducers connected to the recorders, worsening sea conditions dictated that full speed runs on legs 1, 2 and 8 of the octagonal course, be abandoned. These were repeated later under calmer conditions just inside the heads of Jervis Bay.

One of the two recorders also stopped during the 4000 RPM runs, so no further records were obtained from this unit.

5. TABULATION OF TEST RESULTS

Because of the large volume of data recorded during the trials, only a representative sample is presented in this report.

The results are presented in tables 2, 3, 4 and 5 and shown in diagramatic form in FIGS. 8 to 21 inclusive.

5.1 Calm Water Trials

Straight runs into the sea yielded identical results to those with a following sea, so only the former results were tabulated.

Runs at 2000 RPM were disregarded as the magnitude of the output was insignificant for all sensors.

Full helm and half helm turns to Port and Starboard showed no significant difference between results obtained from runs at 2000 RPM and those at 3000 RPM. Likewise runs at 4000 RPM and full speed were virtually identical so only the 3000 RPM and full speed results were tabulated.

5.2 Rough Water Trials

There was no significant difference between results obtained at 2000 RPM and 3000 RPM so only the 3000 RPM readings were tabulated.

Most of the records from runs at 4000 RPM were lost, because of a malfunction in the recording system under the rough sea conditions.

Runs at full engine RPM were tabulated for both the rough water and slightly calmer water conditions mentioned in 4.2.2.

6. TEST RESULTS

6.1 Pressure Readings

Because of the failure of 10 pressure transducers during the trials and the unsuitability of the 60 PSI units for the small pressures recorded, a pressure plot of the inside of the tunnels was not possible.

In general, the magnitude of the pressures were small with a maximum value of 8.3 PSI (57.2 KPA) at position P2 in the foreward part of the tunnel, recorded at full speed on the octagonal course.

The peak pressures depended mainly on speed through the water, with little variation due to the sea state or the direction relative to the sea.

Both positive and negative pressures were measured at all positions. The results are tabulated in tables 3 and 5.

6.2 Strain Readings

The maximum peak strain was - 760 microstrain (compression) on gauge S24, located on the side of the hull near the transom. This was recorded during a full helm turn to starboard, at full engine RPM.

The values of strain were mainly dependent on the speed of the boat through the water with some variation due to sea conditions.

As expected, maximum strain, pressure and acceleration occurred simultaneously.

A tabulation of peak strains are shown in tables 2 and 4.

6.3 Acceleration Readings

Peak acceleration at the front of the hull and at the CG position were 2.6G and 1.7G respectively. These are tabulated with pressures and strains in tables 2 to 5.

7. GENERAL COMMENTS

Environmental conditions encountered during the trials were more severe than had been anticipated. It was not possible for the instrumentation operator to monitor the operation of equipment, particularly during rough water trials, as he was fully occupied in

operating the record switch and holding on to prevent himself being hurled around the boat. Consequently malfunctions were not detected until later and some data was lost.

Rise times were much faster than had been anticipated, both the boat and recording equipment being subjected to repeated heavy impact loading, which caused on intermittent fault in the paper drive mechanism of one recorder and system wiring to fail in fatigue.

The obsolete photographic recorders used during the tests were not really suited to the harsh environment but were the best available at the time.

Failure of two strain gauges in the latter part of the tests was attributed to moisture penetrating the protective coating of gauges immersed in salt water in supposedly dry areas. Access to some gauge locations was barely adequate for proper attachment and protection of the gauges.

8. CONCLUSIONS

In a test of this type, rugged, modern data acquisition and recording equipment should be used, carefully shock mounted and proofed against the harsh environment.

Solid state equipment should be used in the target vessel, the transducer inputs being multiplexed and telemetered from the boat to a relatively stable platform on shore or in a larger ship where the data could be continuously monitored and recorded using high quality instrumentation recorders.

Time should also be allotted for testing the transducers under their operating environment and if necessary replacing them with more suitable units should problems arise, even if this involved additional delays and costs to the project.

TABLE 1

TRANSDUCER TYPE AND RECORDER CHANNEL ALLOCATION

TRANSDUCER NUMBER	TRANSDUCER TYPE	PRESSURE RANGE INITIAL RUN	PRESSURE RANGE FINAL FUNS	RECORDER	CHANNEL NUMBER
A29	Accelerome-ter				1
A28	"				2
P1	Pressure	0-60 PSI	±5 PSI		3
P3	"	"	"		4
P7	"	±5 PSI	"	CENTURY	5
P8	"	"	NOT FITTED		6
P9	"	"	"		7
P11	"	0-60 PSI	"		8
P14	"	"	"		9
P16	"	"	"		10
A29	Accelerome-ter				1
S17	Strain Gauge				2
P2	Pressure	60 PSI	±5 PSI		3
P4	"	"	"	CEC	4
P5	"	"	±30	Pressure	5
P6	"	"	NOT FITTED	Configuration	6
P10	"	±5 PSI	±5 PSI		7
P13	"	"	"		8
P12	"	"	NOT FITTED		9
P15	"	"	"		10
A29	Accelerome-ter				1
S18	Strain Gauge				2
S19	"				3
S20	"			CEC	4
S21	"			Strain	5
S22	"			Configuration	6
S23	"				7
S24	"				8
S25	"				9
S26	"				10
S27	"				11
TIMING LIGHT - ONE PULSE PER SECOND				Century	12
" " " " "				CEC	13

TABLE 2

HYDROFIELD 20 TEST CALM WATER TRIALS

TEST CONDITIONS	TRACE	STRAIN GAUGES STRAIN x 10^{-6}										ACCELEROMETERS G	
		S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	A28	A29
Straight Run Into Sea	+ve Peak	+135	0	+107	0	+26	+57	+130	0	-17	0	+0.8	+0.3
	Average	+54	0	+57	0	-36	-52	+68	0	-57	0	-	-
Engine 3000 RPM	-ve Peak	-225	0	-250	0	-62	-90	+56	0	-71	0	-0.9	-0.4
Straight Run Into Sea	+ve Peak	+104	+156	+236	+40	+36	+71	+169	+61	+38	+10	+1.5	+0.7
	Average	0	+26	-107	0	0	0	+68	+25	-33	0	-	-
Engine 4000 RPM	-ve Peak	-450	0	-428	-46	-78	-48	-85	-10	-94	-10	-1.6	-0.4
Straight Run Into Sea	+ve Peak	+99	+104	+214	+40	+31	+95	+225	+101	0	0	+0.9	+1.1
	Average	0	26	-250	0	0	0	+85	+40	-38	0	-	-
Engine Full Speed	-ve Peak	-369	0	-500	-46	-62	-57	-124	-51	-71	0	-1.3	-0.7
Port Turn Half Helm	Peak	-270	+26	+93	+18	-78	+71	+270	-303	-47	0	±0.3	±1.7
Engine 3000 RPM	Average	+113	0	+50	0	-16	0	+225	-152	-42	0	0	0
Port Turn Half Helm	Peak	0	0	-14	+92	+42	+43	+282	-111	-118	0	±1.2	±0.9
Engine Full Speed	Average	+90	0	0	+69	+16	0	+253	-61	-94	0	0	0
Starboard Turn Half Helm	Peak	-248	0	+93	+9	-52	+86	-197	+51	+57	0	±0.3	±1.7
Engine 3000 RPM	Average	+113	0	+36	0	-16	-10	-119	+30	+47	0	0	0

.../contd.

TABLE 2 (CONTD.)

TEST CONDITIONS	TRACE	STRAIN GAUGES STRAIN x 10^{-6}										ACCELEROMETERS G	
		S18	S19	S20	S21	S22	S23	S24	S25	S26	S27	A28	A29
Starboard Turn Half Helm	Peak	-585	0	+36	+92	-52	-95	-450	+116	+47	0	±1.2	±0.9
Engine Full Speed	Average	-225	0	0	+46	-42	0	-162	+76	+38	0	0	0
Port Turn Full Helm	Peak	-77	0	-14	+9	-21	-24	+225	-61	-89	-29	±0.3	±1.3
Engine 3000 RPM	Average	-45	0	0	0	-16	-14	+186	-41	-85	-19	0	0
Port Turn Full Helm	Peak	-162	0	-71	+23	+16	+19	+394	-92	-108	0	±1.6	±0.4
Engine 4000 RPM (No Data Full Speed)	Average	-135	0	0	0	0	0	+366	-76	-94	0	0	0
Starboard Turn Full Helm	Peak	+104	0	+107	+9	-47	-76	-265	+15	+14	-19	±0.3	±1.3
Engine 3000 RPM	Average	+90	0	+71	0	-26	+10	-197	0	+19	-10	0	0
Starboard Turn Full Helm	Peak	-540	0	+143	+23	-78	-95	-450	+91	+47	0	±1.6	±0.6
Engine 4000 RPM	Average	-225	0	+71	0	-52	0	-394	+71	+28	0	0	0
Starboard Turn Full Helm	Peak	-450	+10	-357	+28	-135	+71	-760	+15	+61	+20	±0.1	±1.1
Engine Full Speed	Average	-112	0	-107	+14	-52	0	-704	0	+47	+10	0	0

NOTE - *Zero readings indicate values too small to be determined from the recordings.*

TABLE 3

HYDROFIELD 20 TEST CALM WATER TRIALS

TEST CONDITIONS	TRACE	PRESSURE TRANSDUCERS (KPA)							ACCELEROMETERS G	
		P2	P3	P5	P7	P10	P13	P15	A28	A29
	+ve Peak	+7.6	+9.6	+9.6	+4.1	+14.5	+1.5	0	+0.92	+0.43
Straight Run Into Sea	Average	0	0	0	-3.0	+6.3	0	0	-	-
Engine 3000 RPM	-ve Peak	-0.69	-2.3	-3.8	-9.0	-1.2	-0.55	0	-0.84	-0.29
	+ve Peak	+28.2	+9.0	+28.2	+6.2	+36.5	+5.5	+3.0	+0.9	+1.1
Straight Run Into Sea	Average	+3.2	+4.8	0	-9.0	0	+1.4	+0.69	-	-
Engine 4000 RPM	-ve Peak	0	0	0	-23.4	-15.8	-3.8	-0.28	-1.3	-0.7
	+ve Peak	+41.3	+9.0	+32.4	+6.2	+36.5	+10.3	+6.2	+1.3	-0.7
Straight Run Into Sea	Average	0	+4.8	0	-9.0	0	+2.1	+1.4	-	-
Engine Full Speed	-ve Peak	-2.1	0	0	-23.4	-15.8	-2.1	-0.76	-0.92	-1.1
Port Turn Half-Helm	Peak	-	+2.9	-	-6.2	-	-	-	±0.3	±1.7
Engine 3000 RPM	Average	-	0	-	-4.8	-	-	-	0	0
Port Turn Half-Helm	Peak	+44.1	+2.1	+28.2	-15.2	+41.3	+9.0	+5.4	±1.2	±0.9
Engine Full Speed	Average	0	0	0	-9.0	+25.5	+2.9	+2.1	0	0
Starboard Turn Half-Helm	Peak	-	+7.2	-	-13.1	-	-	-	±0.3	±1.6
Engine 3000 RPM	Average	-	0	-	-6.2	-	-	-	0	0

.../contd.

TABLE 3 (CONTD.)

TEST CONDITIONS	TRACE	PRESSURE TRANSDUCERS (KPA)							ACCELEROMETERS G	
		P2	P3	P5	P7	P10	P13	P15	A28	A29
Starboard Turn Half-Helm	Peak	+31.6	+5.8	+37.8	-15.2	+37.9	+4.9	+9.0	±1.2	±0.9
Engine Full Speed	Average	0	+2.9	0	-9.0	+25.5	+2.9	+3.0	0	0
Port Turn Full Helm	Peak	-	+2.1	-	-6.2	-	-	-	±0.3	±1.3
Engine 3000 RPM	Average	-	0	-	-0.3	-	-	-	0	0
Port Turn Full Helm	Peak	-	+5.8	-	+1.5	-	-	-	±1.6	±0.4
Engine 4000 RPM	Average	-	+2.8	-	+2.1	-	-	-	0	0
(No Data Full Speed Run)										
Starboard Turn Full-Helm	Peak	-	+9.0	-	-6.2	-	-	-	±0.3	±1.3
Engine 3000 RPM	Average	-	+0.9	-	-2.1	-	-	-	0	0
Starboard Turn Full-Helm	Peak	-	+2.8	-	-1.5	-	-	-	±1.6	±0.6
Engine 4000 RPM	Average	-	+1.4	-	-10.3	-	-	-	-	0
Starboard Turn Full-Helm	Peak	-	+4.3	-	-20.7	-	-	-	±1.1	±1.7
Engine Full Speed	Average	-	+2.9	-	-10.3	-	-	-	0	0

NOTE - Zero readings indicate values too small to be determined from the recordings.

TABLE 4

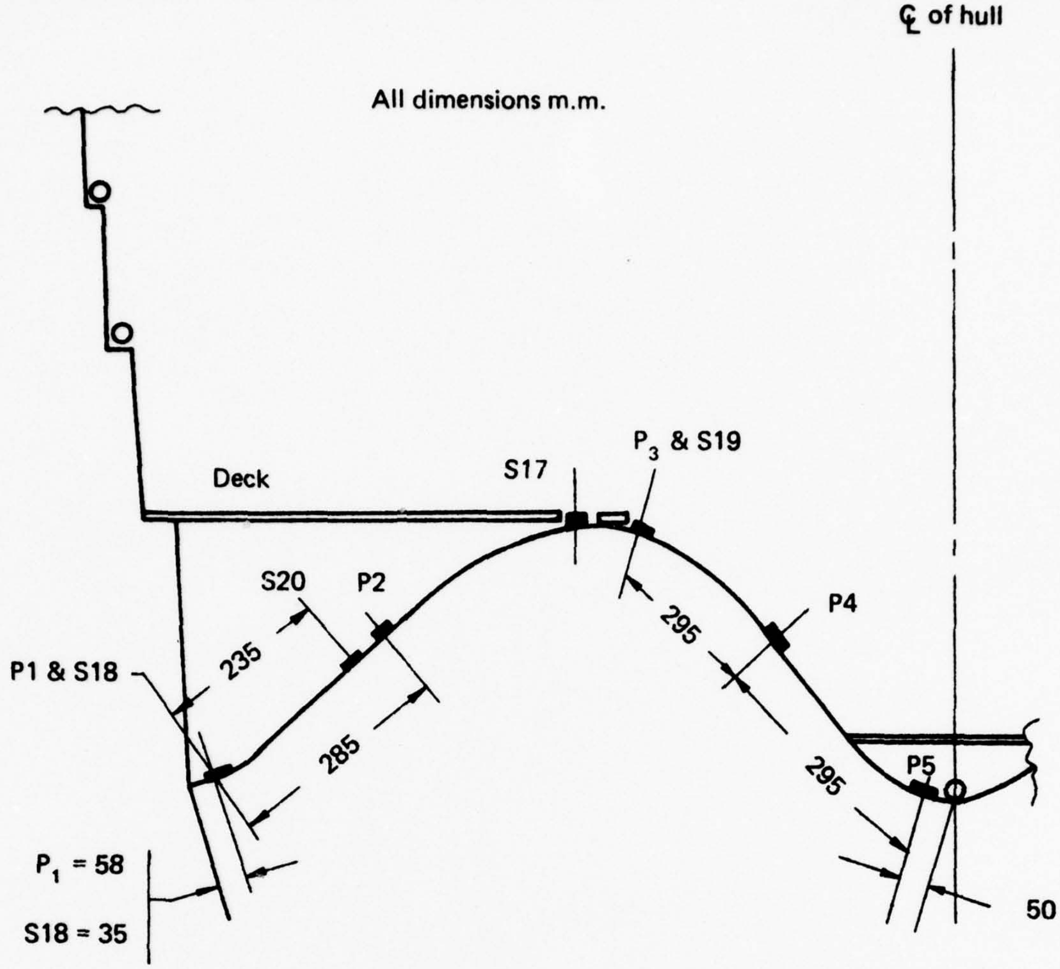
HYDROFIELD 20 TEST ROUGH WATER TRIALS

TEST CONDITIONS	TRACE	STRAIN GAUGES STRAIN x 10^{-6}									ACCELEROMETERS G	
		S19	S20	S21	S22	S23	S24	S25	S26	S27	A28	A29
Octagon course	+ve Peak	+182	+214	+69	+104	+286	+214	+61	+240	+19	+1.1	+0.8
Engine Speed 3000 RPM	Average	0	-	0	-52	-38	0	+15	-28	0	0	0
	-ve Peak	-68	-643	-92	-62	-119	-310	-61	-108	-29	-1.8	-0.7
Octagon course	+ve Peak	Failed	Failed	+92	+104	+238	+225	+101	+212	+143	+1.7	+0.9
Engine Full Speed	Average			0	0	0	0	0	0	+19	0	0
	-ve Peak			-69	-156	-86	-507	-116	-118	-48	-2.6	-1.4

TABLE 5
HYDROFIELD 20 TEST ROUGH WATER TRIALS

TEST CONDITIONS	TRACE	PRESSURE TRANSDUCERS (KPA)						ACCELEROMETERS G	
		P2	P3	P5	P7	P10	P15	A28	A29
Octagon course Engine Speed 3000 RPM	+ve Peak	-	+10.3	-	+16.5	-	-	+1.1	+0.8
	Average	-	0	-	+2.1	-	-	0	0
	-ve Peak	-	-8.9	-	-7.6	-	-	-1.8	-0.7
Octagon course Engine full Speed	+ve Peak	-	+20.0	-	+15.2	-	-	+1.7	+0.9
	Average	-	-0.69	-	-2.1	-	-	0	0
	-ve Peak	-	-9.0	-	-15.8	-	-	-2.[illegible]	-1.4
Octagon course Engine Full Speed (in calmer conditions)	+ve Peak	+57.2	-	+37.9	-	+35.1	+13.3	-	-
	Average	+1.2	-	0	-	+3.4	+2.8	-	-
	-ve Peak	-35.1	-	-9.6	-	-12.4	-7.6	-	-

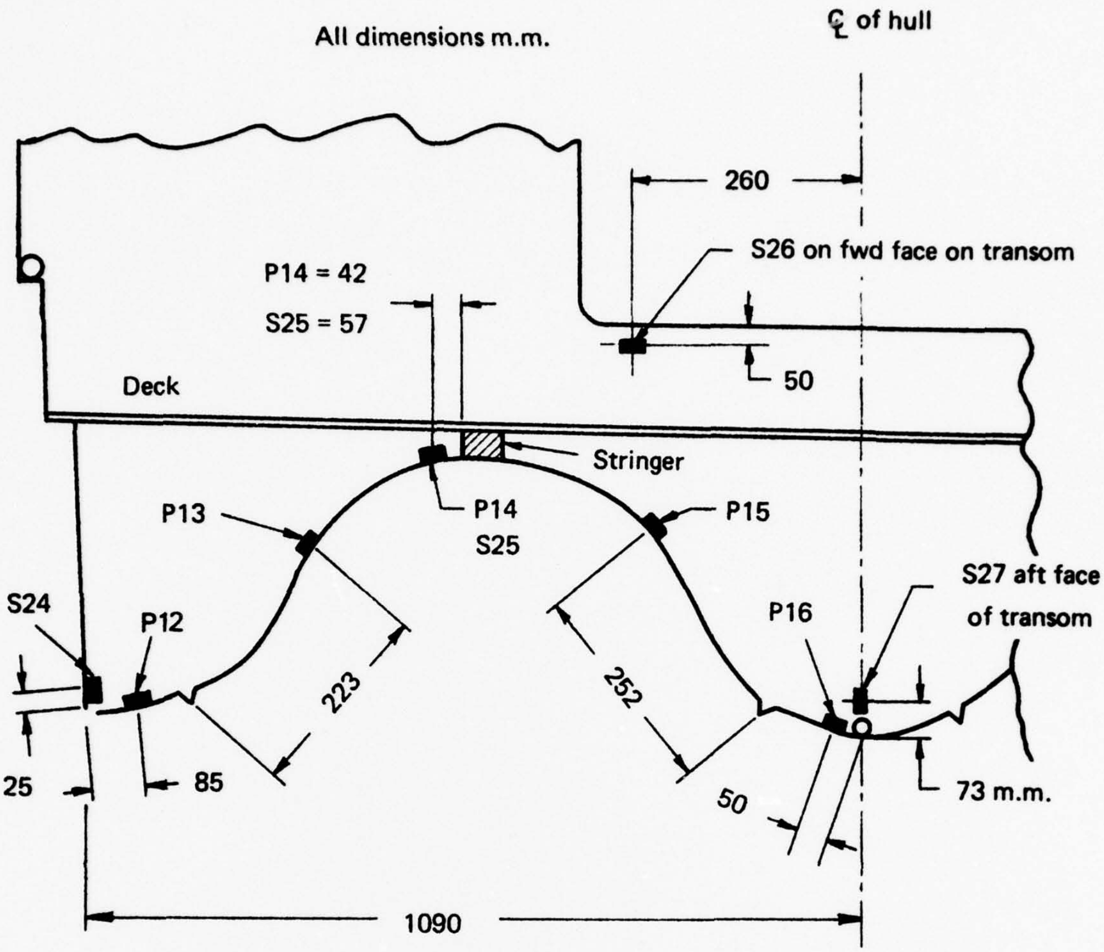
NOTE - Zero readings indicate values too small to be determined from the recordings.



Lower cabin wall bulkhead approx. 3150 m.m. from edge of transom.

P1	235 m.m. Fwd of lower cabin wall bulkhead	
P2	338 m.m. Fwd of Lower cabin wall bulkhead	
P3	320 m.m. Fwd of lower cabin wall bulkhead	
P4	335 m.m. Fwd of lower cabin wall bulkhead	
P5	330 m.m. Fwd of lower cabin wall bulkhead	
S17	905 m.m. Fwd of lower cabin wall bulkhead	Athwart Ship
S18	375 m.m. Fwd of lower cabin wall bulkhead	Athwart Ship
S19	280 m.m. Fwd of lower cabin wall bulkhead	Athwart Ship
S20	50 m.m. Fwd of lower cabin wall bulkhead	Fore and Aft

FIG. 1. TRANSUDCER POSITIONS – PORT SIDE FORWARD

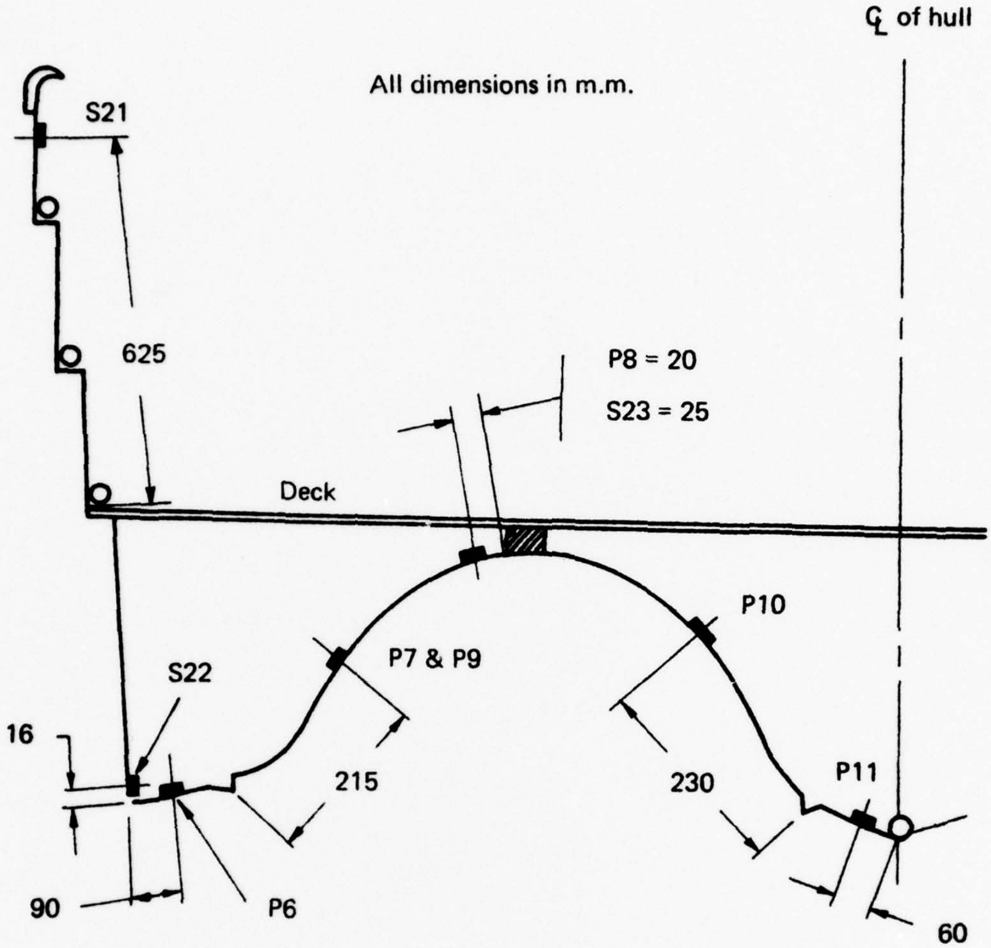


Transducers near aft edge of transom

P12	86 m.m.	Fwd of aft face of transom
P13	88 m.m.	Fwd of aft face of transom
P14	88 m.m.	Fwd of aft face of transom
P15	125 m.m.	Fwd of aft face of transom
P16	88 m.m.	Fwd of aft face of transom

S24	250 m.m.	Fwd of front face of transom	– Vertical
S25	180 m.m.	Fwd of front face of transom	– Athwartship
S26	60 m.m.	Fwd of front face of transom	– Athwartship
S27	0 m.m.	Fwd of front face of transom	– Vertical to bottom

FIG. 2. TRANSDUCER POSITIONS – PORT SIDE – AFT.



Transducers near aft end of fuel tank and 3rd tunnel step aft of bow. – Note – 3rd step is approx. 1920 m.m. fwd. of edge of transom.

P6	78 m.m.	Fwd of step bulkhead	Fwd. of step
P7	80 m.m.	Fwd of step edge	
P8	92 m.m.	Fwd of step edge	
P9	33 m.m.	Aft of step edge	Aft. of step
P10	33 m.m.	Aft of step edge	
P11	38 m.m.	Aft of step bulkhead	

S21	30 m.m.	Fwd of step bulkhead – Fore and Aft
S22	30 m.m.	Fwd of step bulkhead – Fore and Aft
S23	104 m.m.	Fwd of step bulkhead – Athwart Ship

FIG. 3. TRANSDUCER POSITIONS – AMIDSHIPS – PORT SIDE.

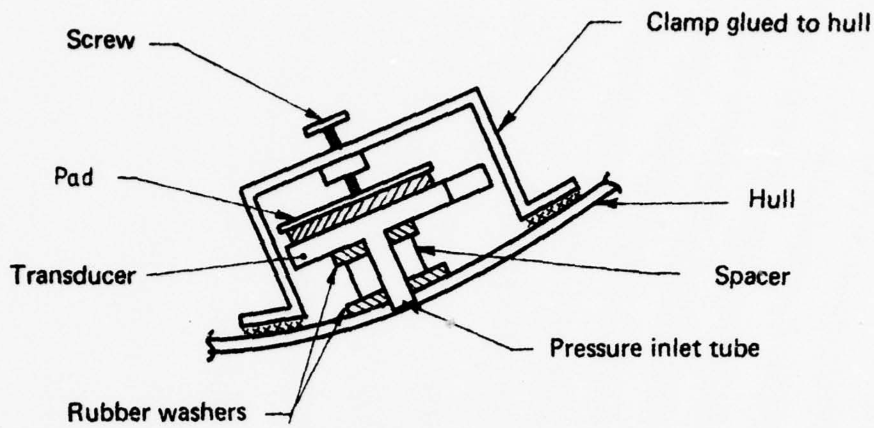


FIG. 4. METHOD OF CLAMPING AND SEALING PRESSURE TRANSDUCER TO HULL.

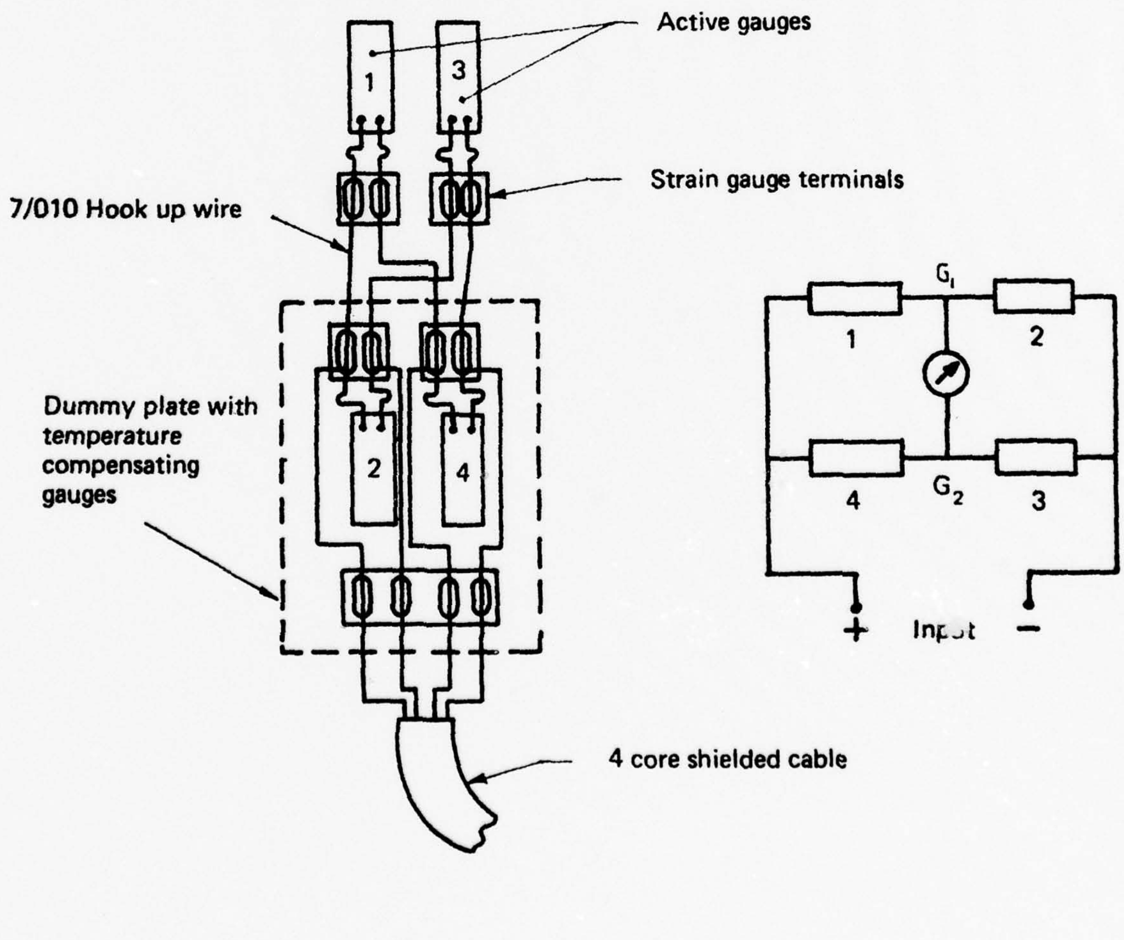


FIG. 5. STRAIN GAUGE BRIDGE

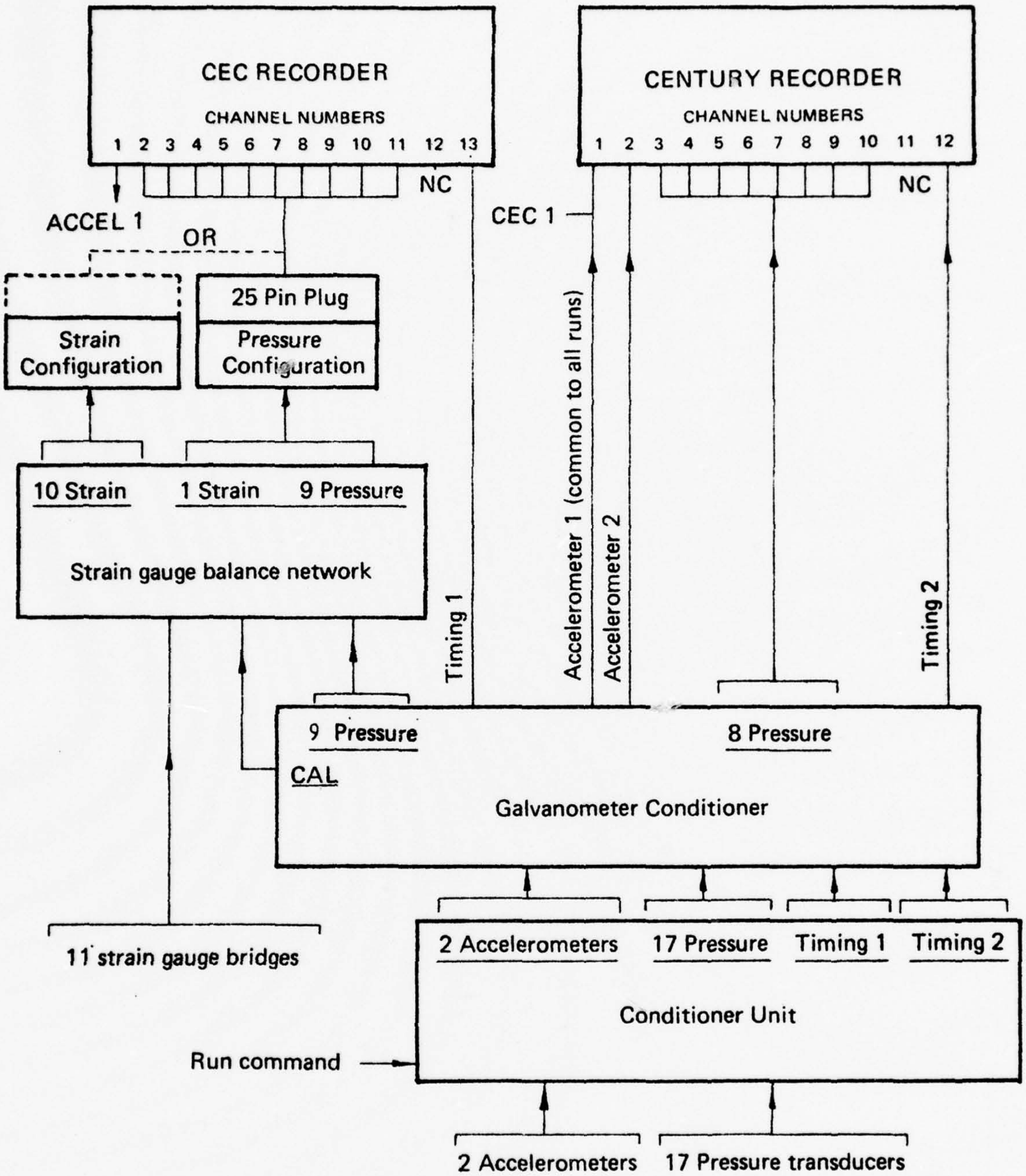


FIG. 6. INSTRUMENTATION LAYOUT

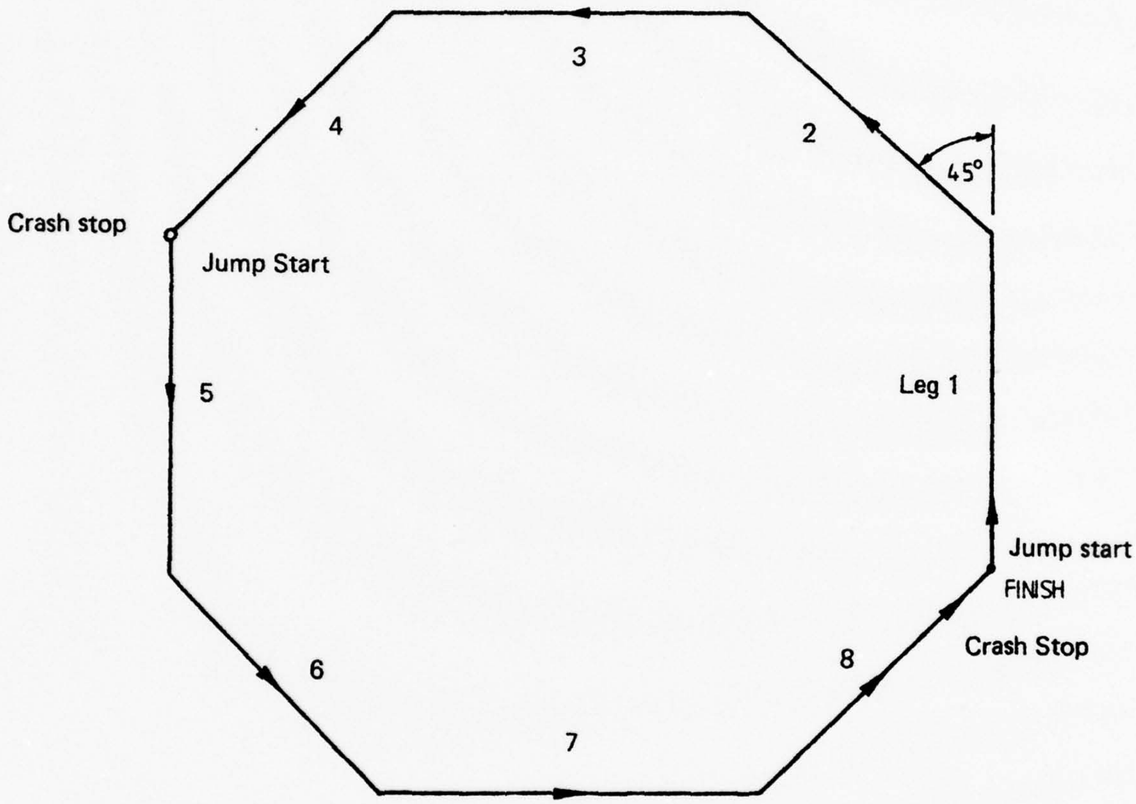
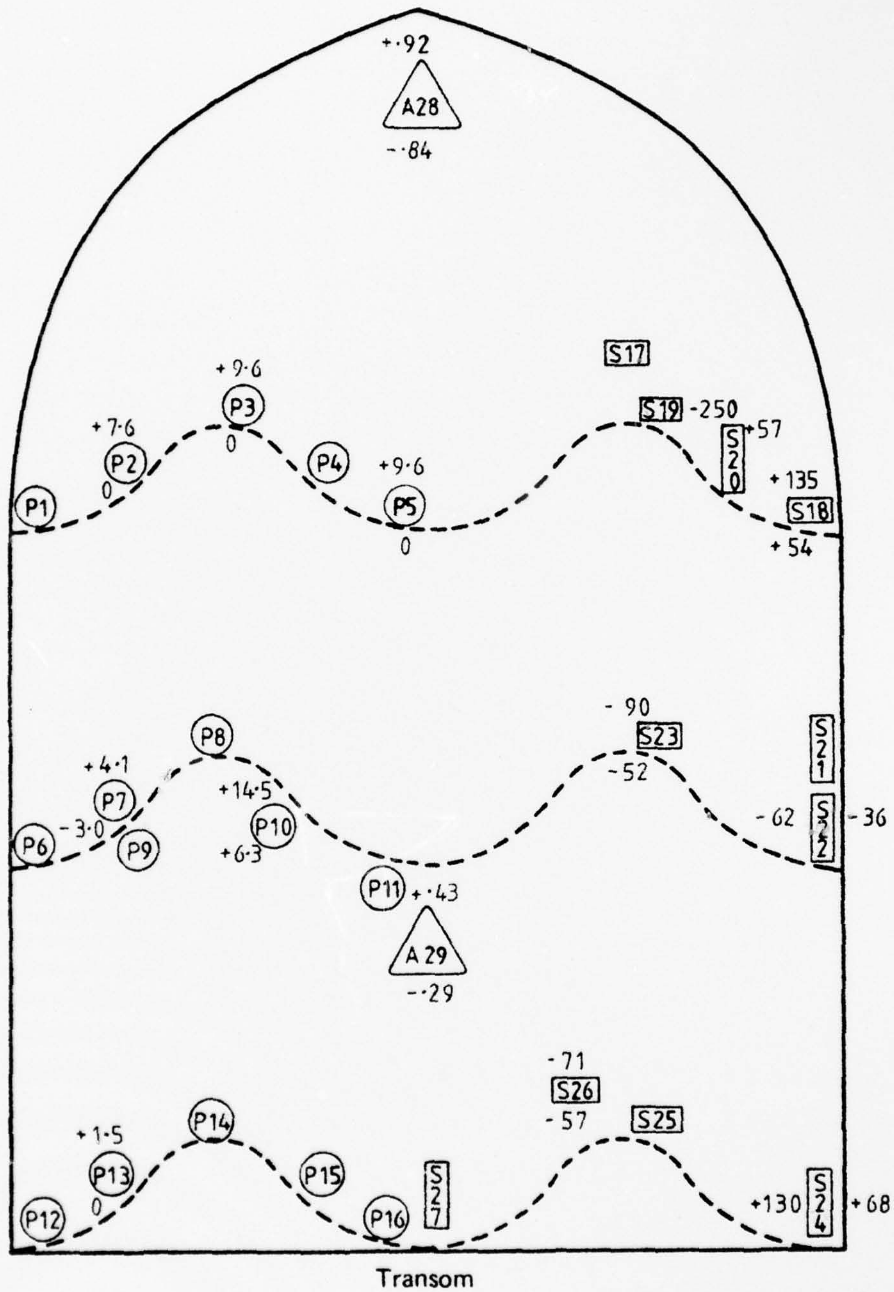


FIG. 7. OCTAGON COURSE FOR ROUGH WATER TRIALS

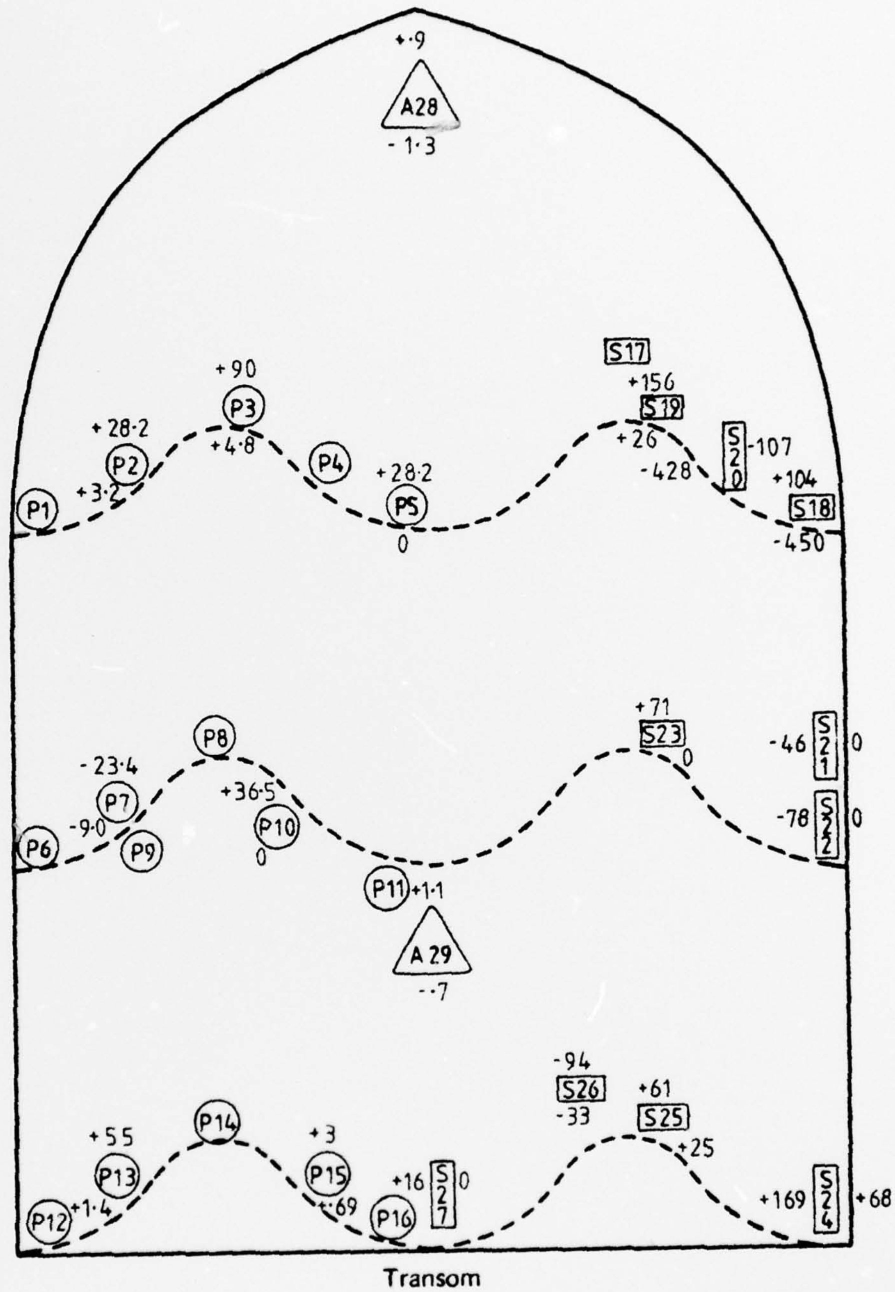
Peak A Average	Accelerometer – 'G'
Peak P Average	Pressure transducer – kilopascals
Peak S Average	Strain gauge (Transverse) – microstrain
Peak S Average	Strain gauge (Longitudinal) – microstrain

Key to figures 8 to 21 inclusive



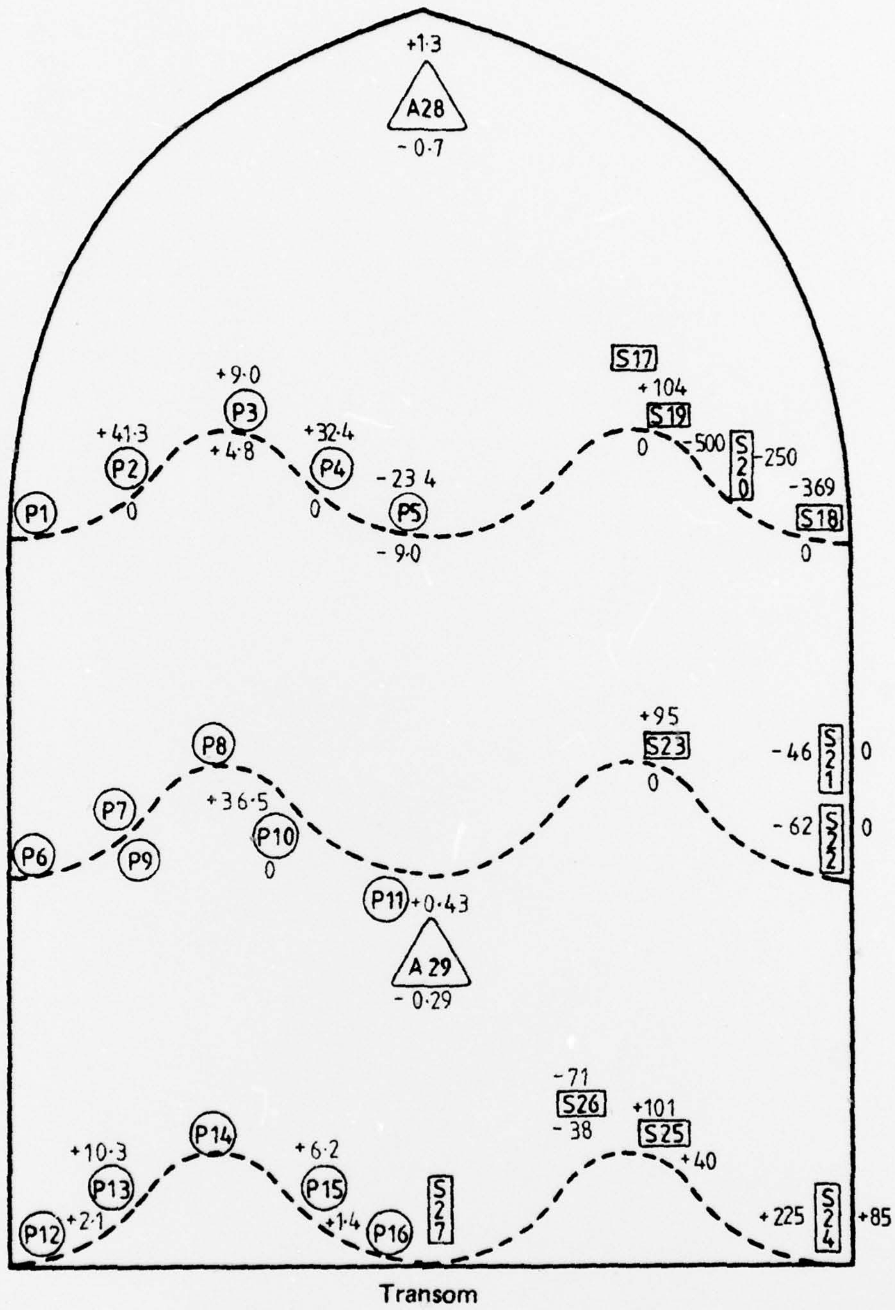
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 8. STRAIGHT RUN INTO SEA ENGINE 3000 RPM CALM SEA



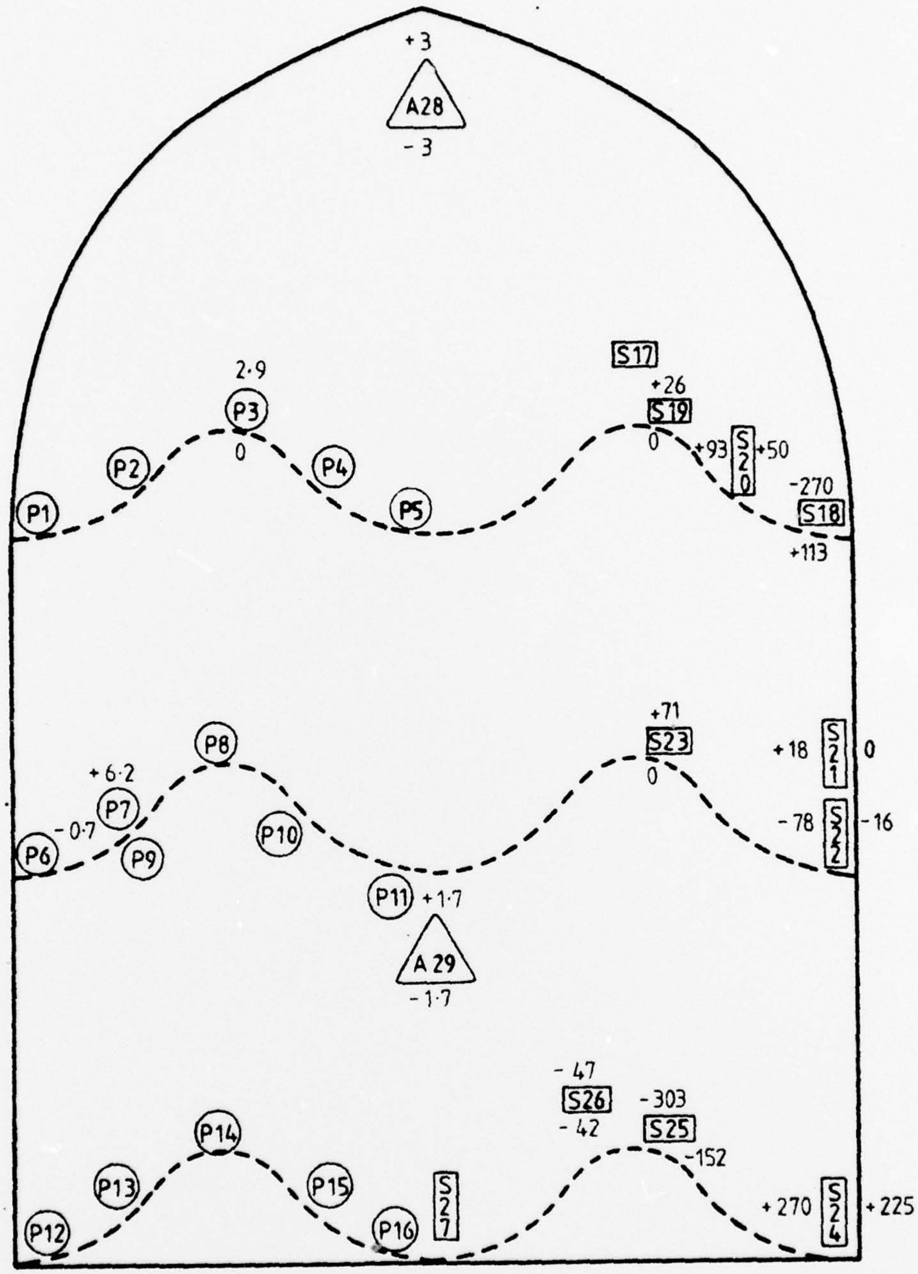
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 9. STRAIGHT RUN INTO SEA ENGINE 4000 RPM CALM SEA



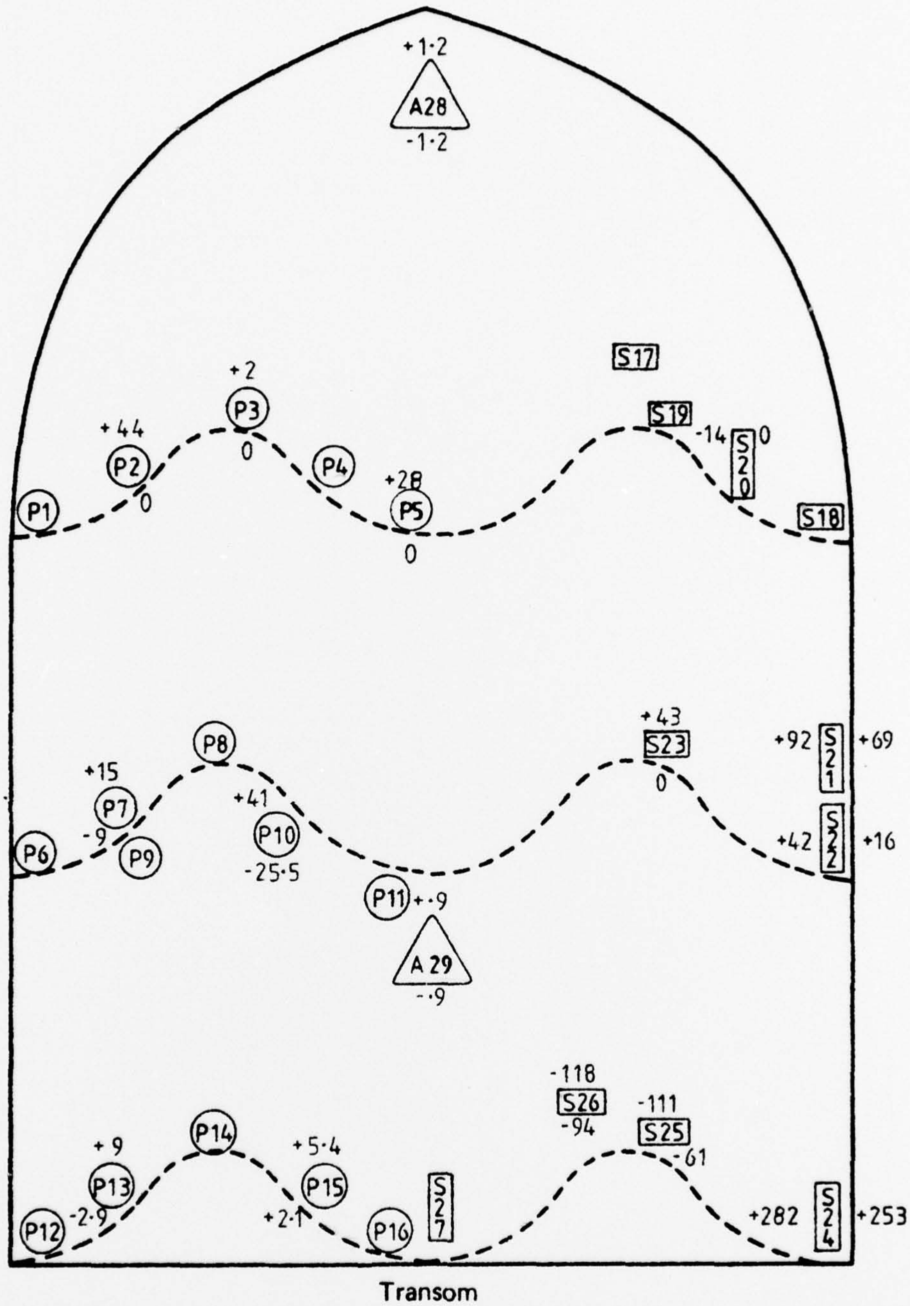
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 10. STRAIGHT RUN INTO SEA ENGINE FULL SPEED CALM SEA



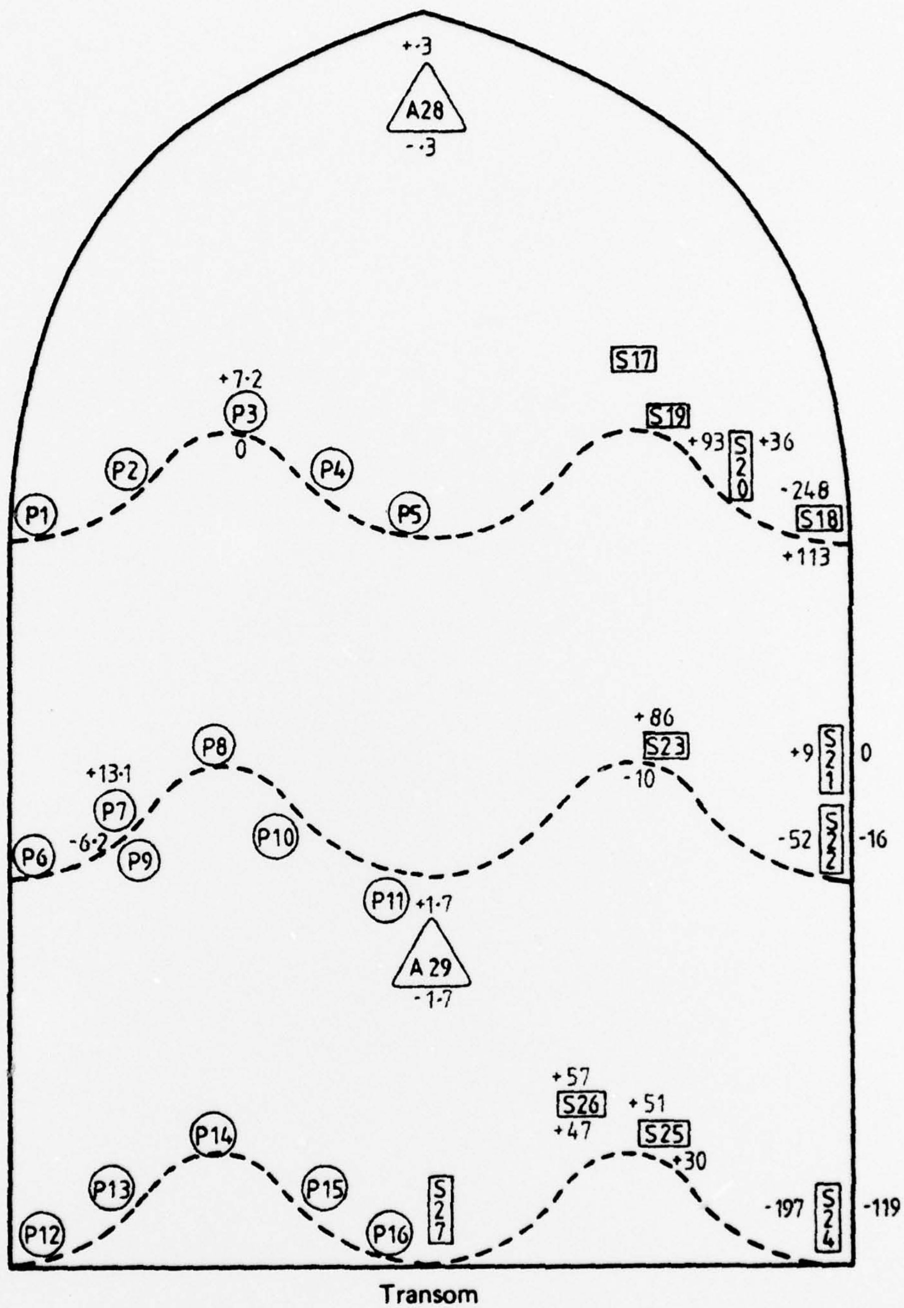
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 11. PORT TURN HALF HELM ENGINE 3000 RPM CALM SEA



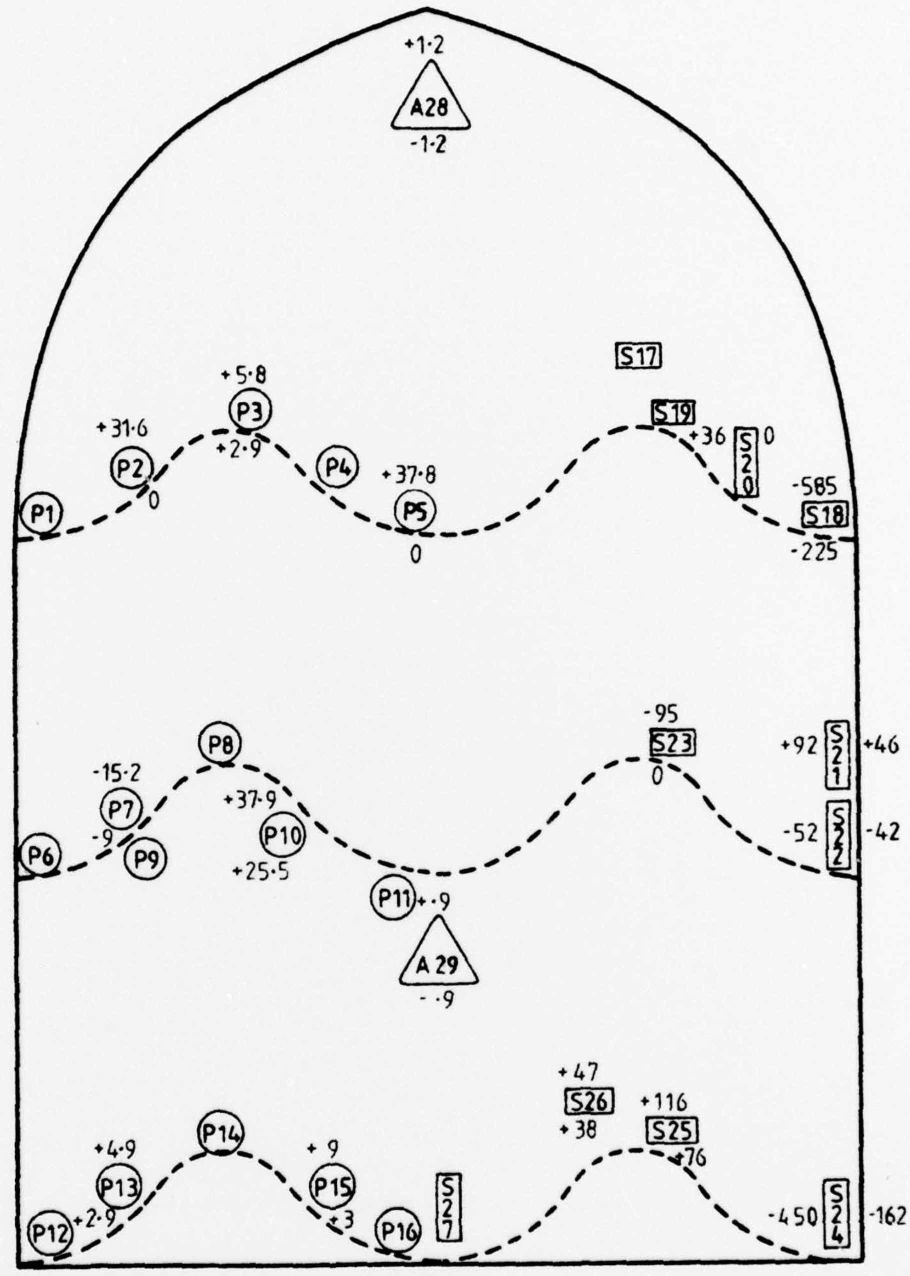
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 12. PORT TURN HALF HELM ENGINE FULL SPEED CALM SEA



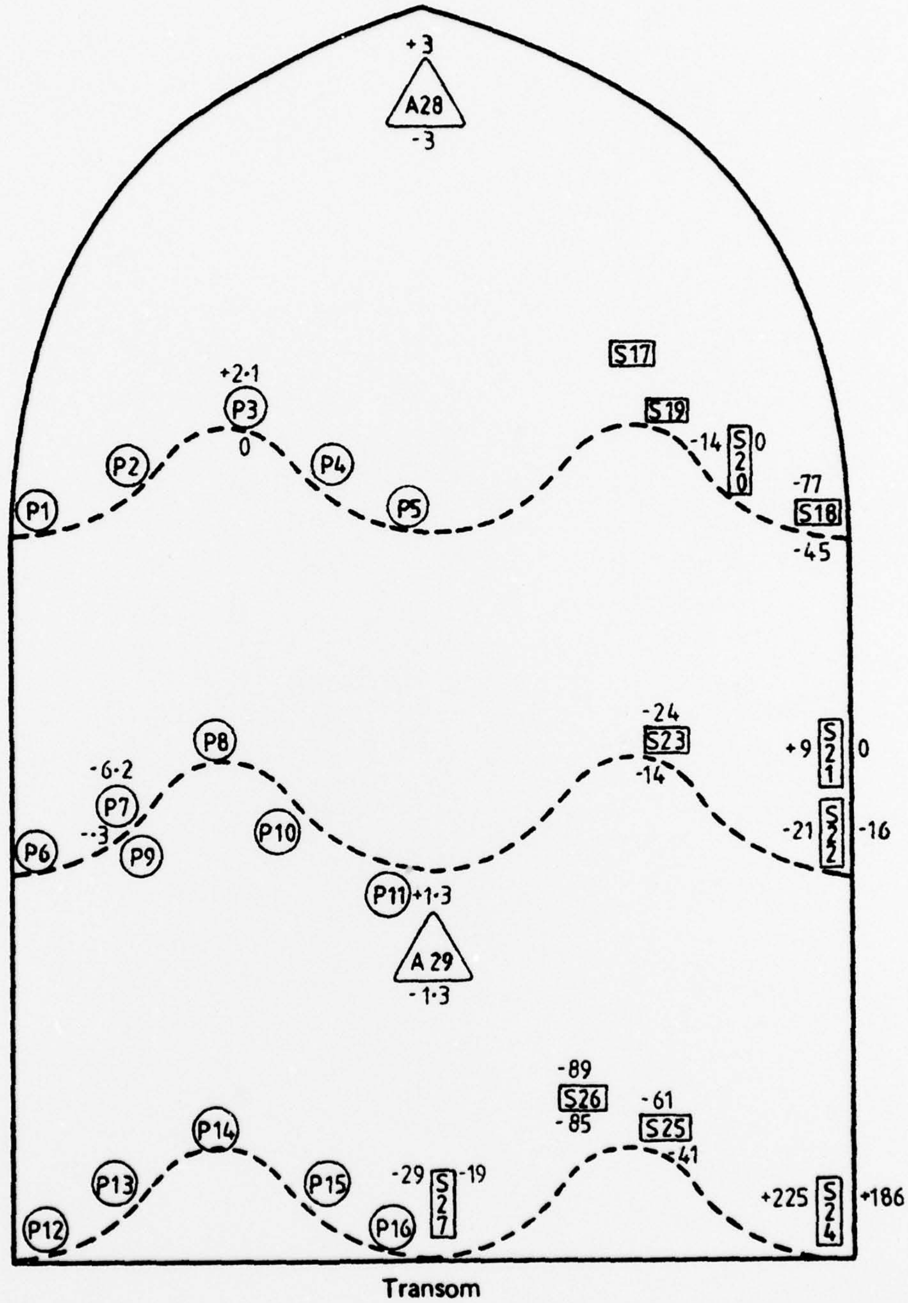
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 13. STARBOARD TURN HALF HELM ENGINE 3000 RPM CALM SEA



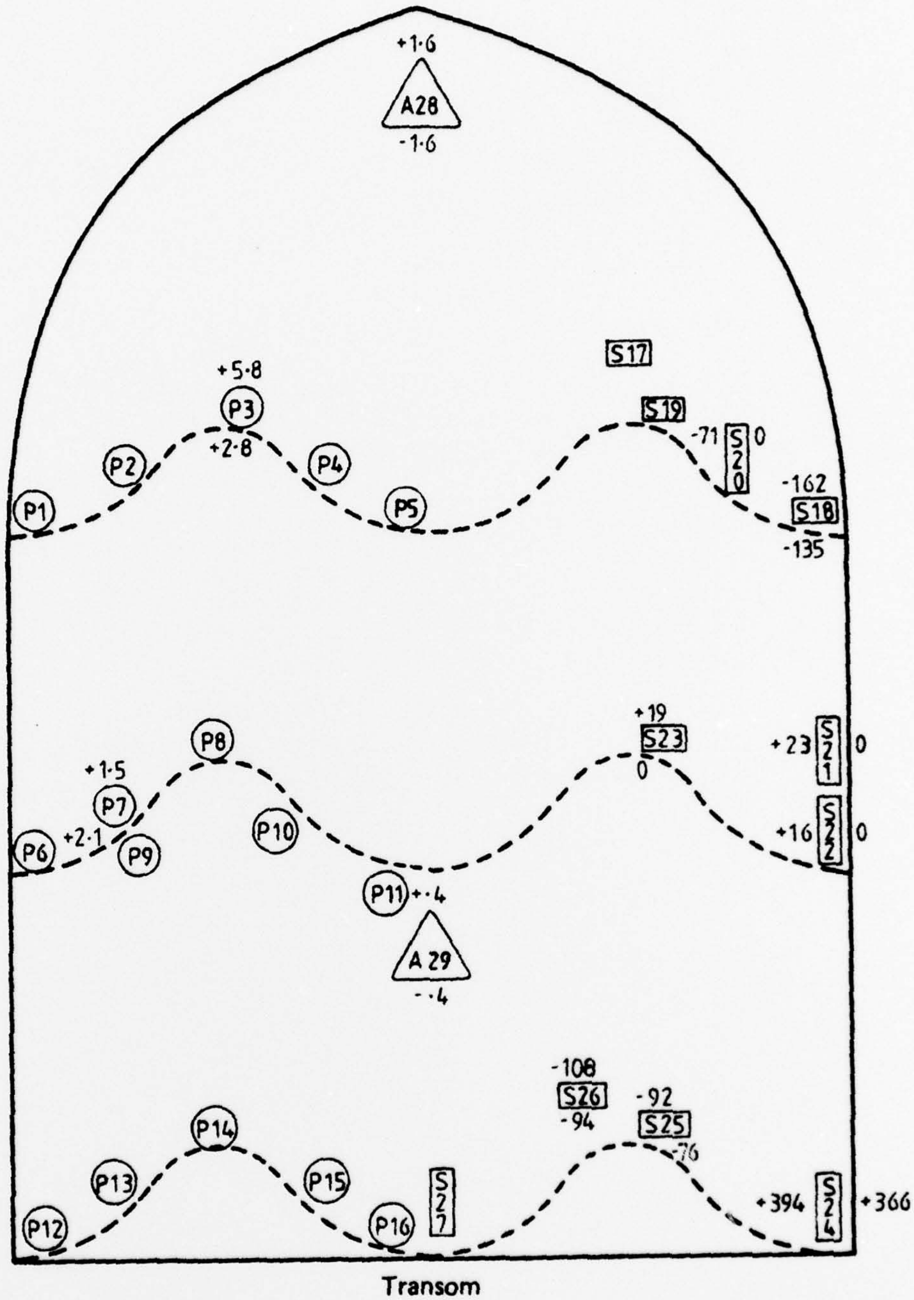
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 14. STARBOARD TURN HALF HELM ENGINE FULL SPEED CALM SEA



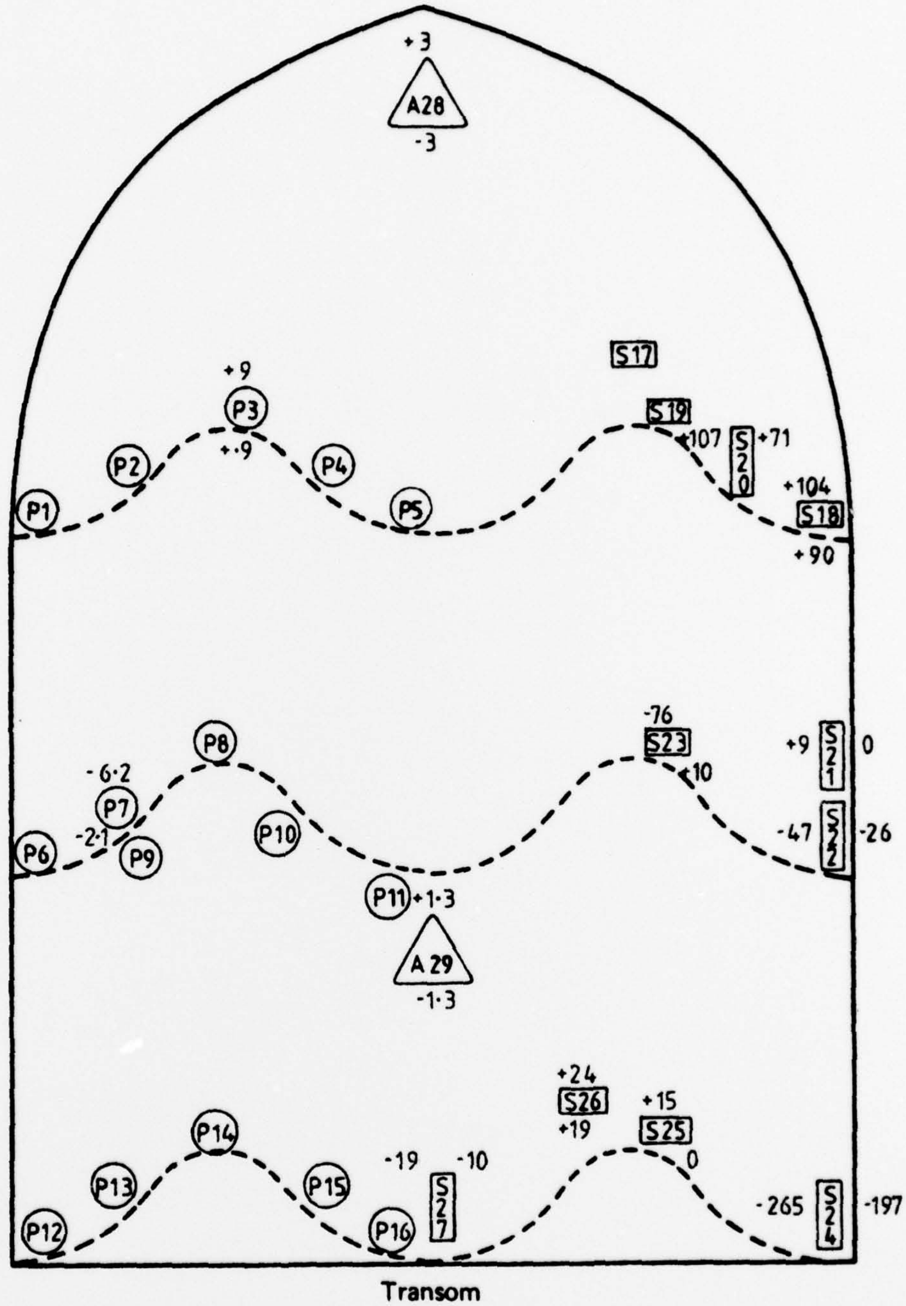
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 15. PORT TURN FULL HELM ENGINE 3000 RPM CALM SEA



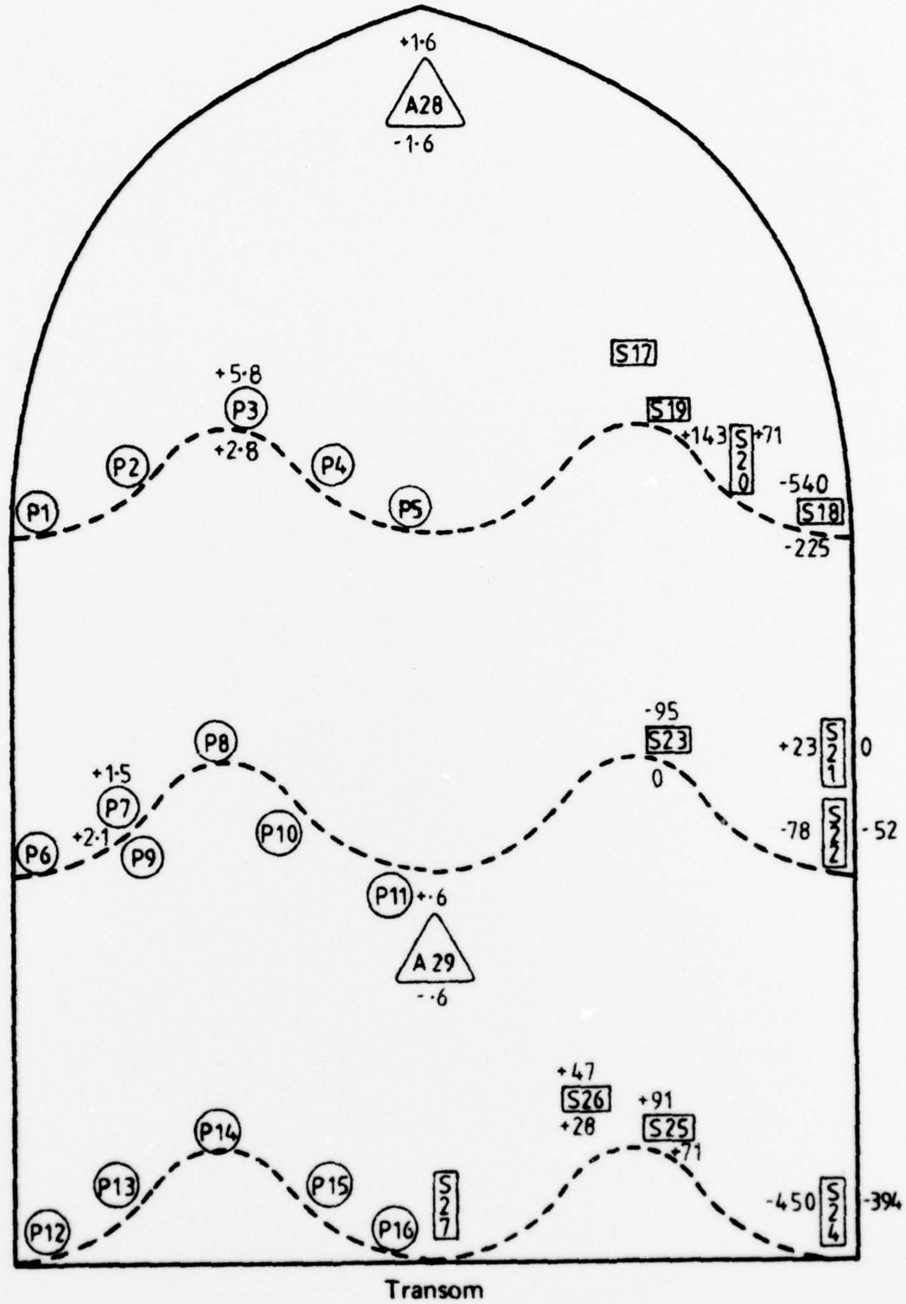
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 16. PORT TURN FULL HELM ENGINE 4000 RPM CALM SEA



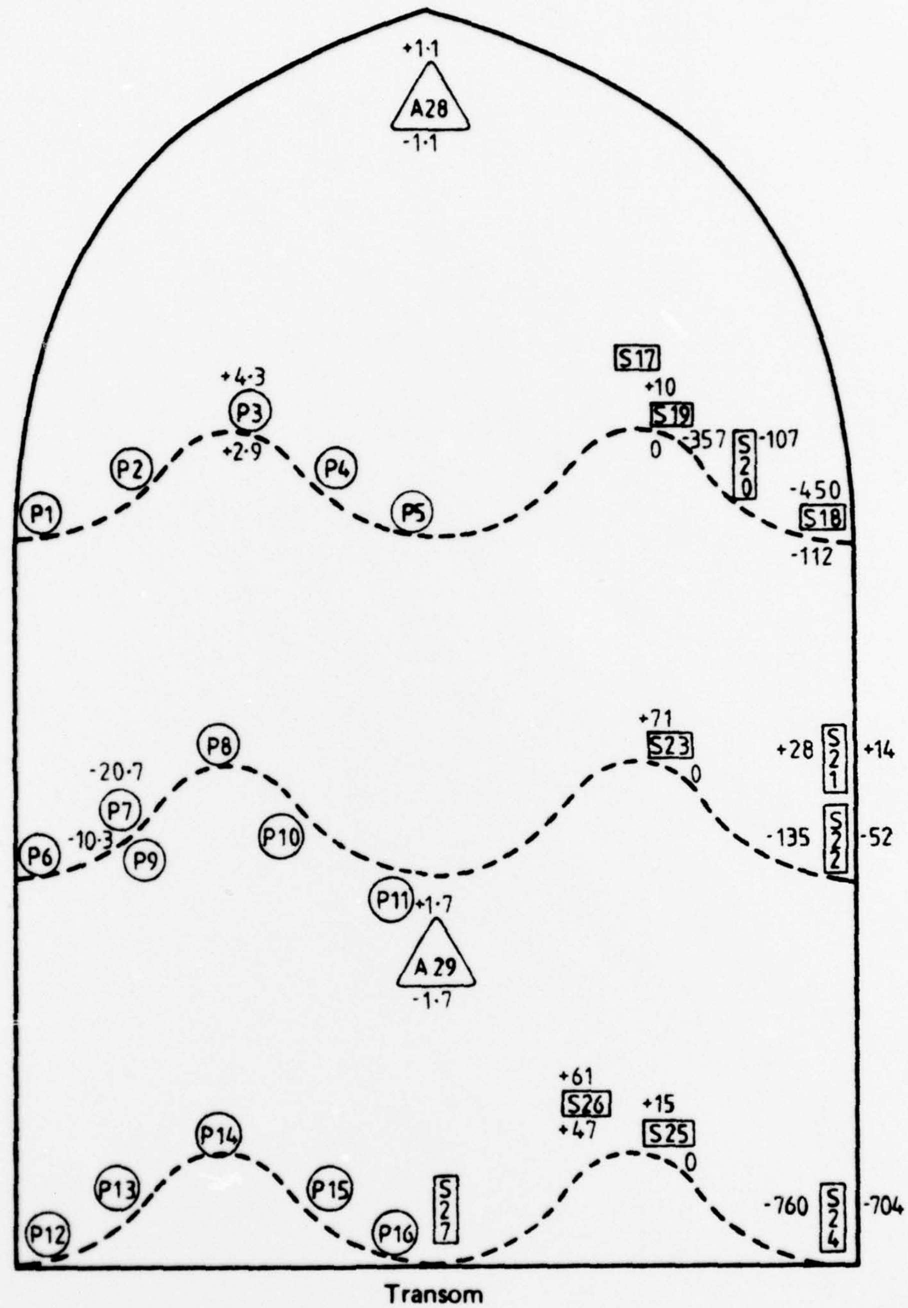
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 17. STARBOARD TURN FULL HELM ENGINE 3000 RPM CALM SEA



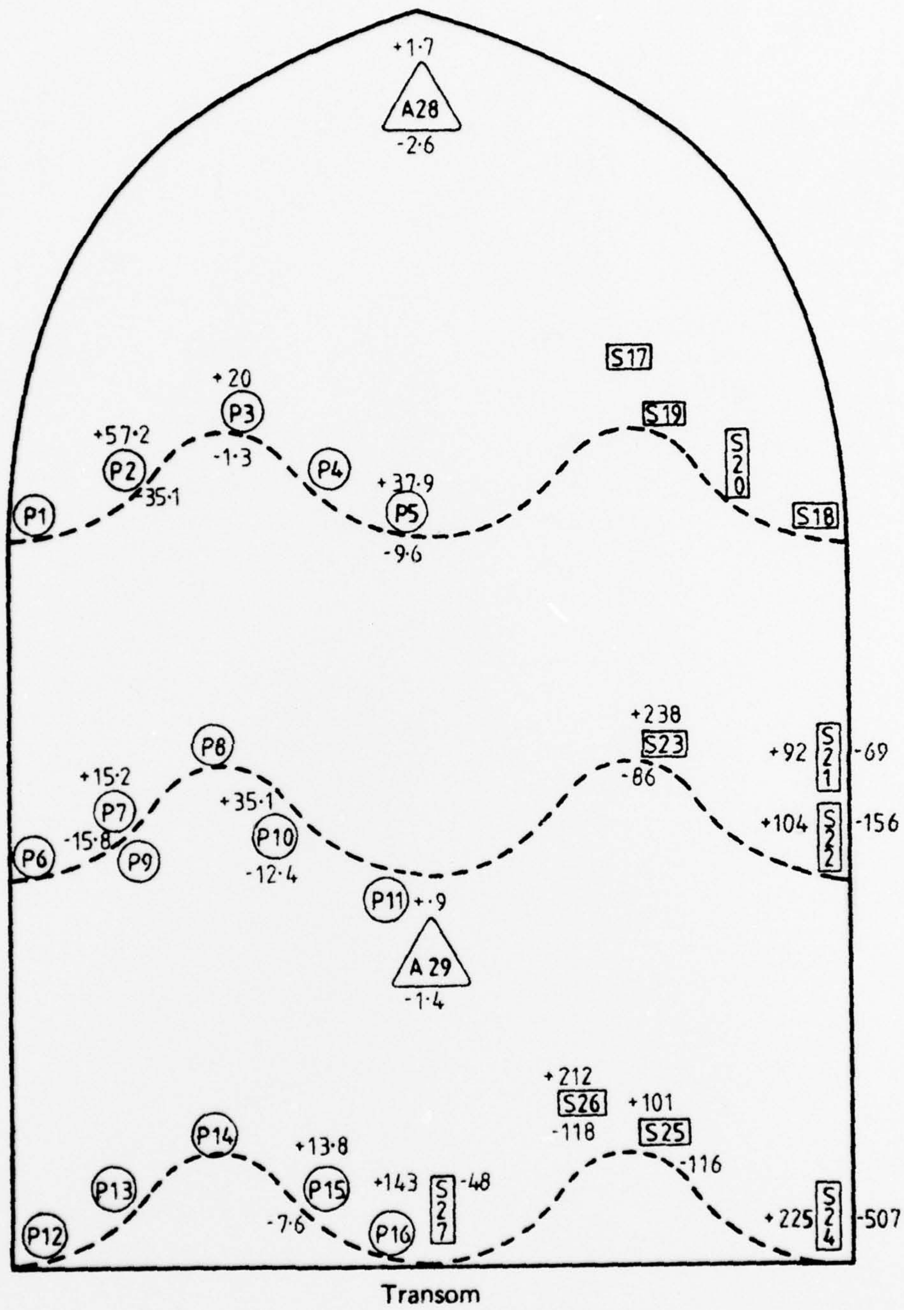
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 18 STARBOARD TURN FULL HELM ENGINE 4000 RPM CALM SEA



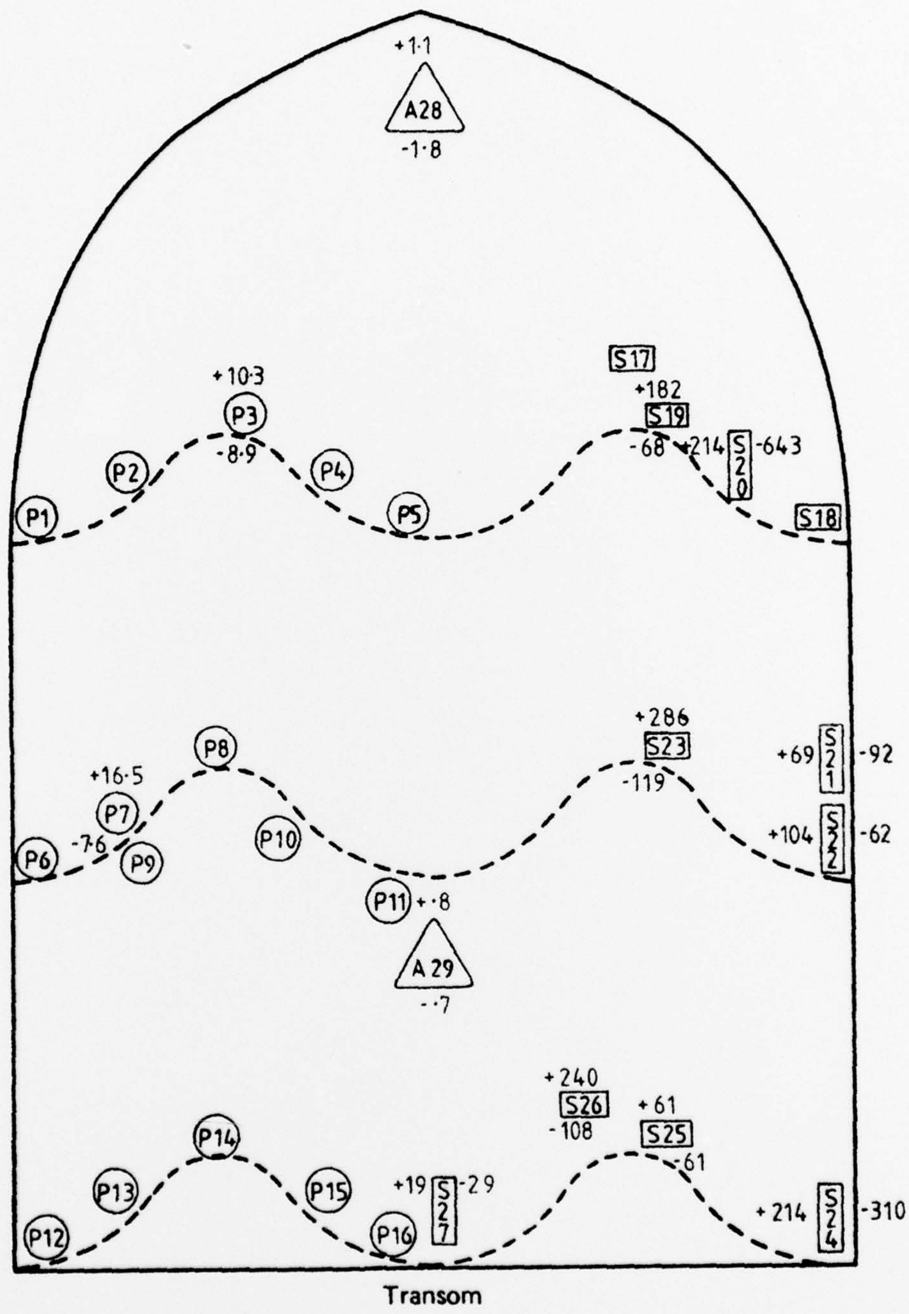
All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 19. STARBOARD TURN FULL HELM ENGINE FULL SPEED CALM SEA



All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 20. OCTAGON COURSE ENGINE FULL SPEED ROUGH SEA



All transducers on port side but strain gauges shown on starboard side for clarity

FIG. 21. OCTAGON COURSE ENGINE SPEED 3000 RPM ROUGH SEA

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	Boats.	

ABSTRACT:

At the request of the Directorate of Naval Ship Design, Aeronautical Research Laboratories (ARL) instrumented a six metre fibre glass target boat and recorded the output signals from pressure transducers, strain gauges and accelerometers during both calm water and rough water trials.

This report details the instrumentation fitted to the hull, the problems encountered during the trials and the results from the tests.

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